



From genes to ecosystems: spatial heterogeneity and temporal dynamics of the Baltic Sea

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Theme session Q

From genes to ecosystems: spatial heterogeneity and temporal dynamics of the Baltic Sea

Conveners: Karin Hüssy (BONUS INSPIRE, kh@aqua.dtu.dk), Jan Dierking (BONUS BIO-C3, jdierking@geomar.de) and Linda Laikre (BONUS BAMBI, linda.laikre@popgen.su.se)

New knowledge of Baltic Sea biodiversity over space and time including its links to ecosystem function, productivity, stability, and adaptive potential was the topical focus of this session. With continuously increasing human induced pressures on the Baltic Sea, understanding spatio-temporal dynamics of genetic, species and community biodiversity is vital for effective management that can aid in retaining environmental functioning and ecosystem services.

The session represented a joint effort between ICES and BONUS, the joint Baltic Sea research and development programme (www.bonusportal.org) and was convened by the three BONUS projects INSPIRE, BIO-C3 and BAMBI.

The interest among conference attendants was high; the 21 oral and 15 poster presentations attracted a large and active audience representing scientists from the three convening and other BONUS projects as well as a substantial number of scientists from outside the BONUS community. An initial discussion revealed that a large proportion of scientists in the BONUS projects are also involved in ICES WGs, and many are using ICES databases or other resources in their work, highlighting the strong and direct connections of the two communities, and the potential for synergies. The enthusiasm for the topics addressed was underscored by a full house over the entire day.

The introducing key note speech was given by Dr Andris Andrusaitis, BONUS Program Manager and was followed by short overviews of the BONUS projects BAMBI, INSPIRE and BIO-C3. The session sub-themes highlighted Spatio-temporal dynamics (5 presentations; Q:01,03,11,13,14), Functional diversity (1 presentation Q:10), Early life stage dynamics (4 presentations; Q:05,06,16,20), Genetic diversity (2 presentations; Q:02,15), Biological responses to anthropogenic drivers (5 presentations; Q:04,07,17, 22,23), Biodiversity and management (3 presentations; Q: 08,12,19) and Poster flash talks. Key take-home messages from the session are briefly summarized below.

Important new pieces in cod spatio-temporal dynamics puzzle. The focus of the Spatio-temporal dynamics sub-theme session was primarily on distribution change, individual migrations, stock mixing and implications for management.

- In recent years the spatial distributions of cod has changed towards a more southerly distribution, concurrent with an apparent increase in stock size. Consequences of this change in distribution are an increased overlap in distribution with flounder and an apparent spill over into the western Baltic Sea management area.
- Spatio-temporal resolution of habitat suitability for spawning showed that the combination of oxygen and salinity requirements for cod egg survival restrict successful spawning to the Bornholm Basin.

- Recruitment is not only governed by habitat suitability but apparently even more so by egg production and larval survival, with higher survival-al during summer.
- The migration of behaviour of individual cod suggests that this species has a relative limited home range, but with a limited number of individuals straying over long distances.
- Together, the limited migrations and the lack of substantial recruitment in the northern areas may be the mechanism for the observed shift in distribution.
- The combined use of genetics and otolith shape provide a useful tool for resolving spatio-temporal patterns of stock mixing between eastern and western Baltic cod – an approach which serves as example for science-based management.
- Genetic structure on socio-economically important species feeds Baltic management
- Spatio-temporal genetic pattern of Baltic pike indicate long distance gene flow including over pelagic regions in this highly philopatric, coastal zone species.
- Management activities such a stocking of pike can results in effects on genetic diversity not only at the local scale which in turn call for better documentation and management of stocking activities.
- Spring and autumn spawning herring show genetic divergence indicating reproductive isolation pointing to a strong need for managing these two components separately. This is not done currently in e.g. the Gulf of Riga, which calls for change of current management practices.
- A review of current knowledge of genetic diversity of Baltic Sea species of practical use for management is underway and is conducted as a response to data specifically asked for by managers.
- The genotypic background plays a significant role for the key zooplankton species calanoid copepod *Eurytemora affinis* to adapt to lower salinity and higher temperatures.
- The combination of an increase in oxygen depletion zones and a reduction in the number large individuals in the Eastern Baltic reduce levels of genetic variation in cod, as the number of females contributing successfully to reproduction decline. These findings illustrate that the combined stress from environmental pressure and fishing can reduce adaptive potential of economically and ecologically important species.

A panel discussion on Baltic Sea genetic biodiversity agreed that knowledge of spatio temporal genetic variability patterns and factors governing this divergence is of key importance for understanding the potential of Baltic biodiversity to adapt to the rapid environmental change. The discussion also highlighted the interest in innovative solutions to address current is-sues in Baltic fisheries management (e.g. use of genetic methods to pinpoint cod age), but also revealed that technologically feasible approaches are un-likely to emerge in the foreseeable future.

Other important contributions

- A new BONUS research project (BLUEPRINT) will shed light on how microbial genetic indicators can be used to monitor environmental status.

- Two studies that focuses on Baltic Sea managers reveal that 1) managers find genetic diversity important but still seldom use it in management due to lack of understanding on how this should be done, 2) differences in training, culture, experience, gender and other factors can lead to dramatic differences in how individuals perceive ecosystem structure and function.
- Implications of invasive species may range from being a potential competitor for habitat and food, exemplified by the round goby to improving water quality by reducing the consequences of eutrophication by filter-feeding molluscs.
- Functional characteristics seem to be a better indicator of ecosystem change than species richness, and document temporal shifts in both benthic macro fauna and fish.

Summary

The presentations within Theme Session Q thus represented a vast range of research topics within the Baltic Sea, spanning from the Bothnian Bay to the Belt Sea, from bacteria over copepods and molluscs to fish, from native as well as invasive species, from individuals to populations, using genetics, field observations as well as modelling approaches. The session highlighted the need for the importance of taking into account spatio-temporal heterogeneity of species distribution with particular emphasis on biological and genetic diversity. It also highlighted the need for a close cooperation between scientists and managers in order to outline science-based sustainable management of resources, and the relevance of the new scientific output resulting from the BONUS projects INSPIRE, BIO-C3, BAMBI and others to ICES Working Groups and fisheries management in the Baltic Sea.